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Method for monitoring the pressure of motor vehicle tires

The invention relates to a method for monitoring the pressure of motor vehicle tires as claimed in the precharacterizing clause of patent claim 1.

Various apparatuses and methods for monitoring the pressure of motor vehicle tires are known from modern vehicles or from the literature. For example, US 5,694,111 describes a tire pressure indicator by means of which the pressure data which is detected by a pressure sensor is compared with a predetermined operating pressure range. An abnormal state of the air pressure is indicated as a function of the comparison result.

DE 101 36 831 A1 discloses a method and an apparatus for monitoring the pressure of pneumatic tires, by means of which an abnormal state of the pressure and/or the temperature of the individual tires of the vehicle can be monitored. The pressure and/or the temperature of the individual tires on the vehicle are/is monitored by means of the method. In this case, it is possible to distinguish between individual pneumatic tires on the vehicle, in order to verify which tire is in an abnormal state. It is also known from DE 101 36 831 A1 for the monitoring apparatus to be controlled by operation of the vehicle key, or for the monitoring apparatus to be used to compare the present state of the tire with that state of the tire which was present when the motor vehicle was started. If the difference between the air pressure values is in this case greater than a predetermined value, the tire is classified as being in a slow leakage state.

DE 101 05 641 A1 discloses a tire pressure monitoring system which combines a direct measuring system by means of a pressure sensor with an indirect measuring system based on a wheel rotation speed sensor system. In the case of this tire pressure monitoring system, the indirect measuring system is calibrated by means of the detected tire pressure values of the direct measuring system. There is no need for manual calibration of the direct measuring system, for example by manually inputting tire pressure values and subsequent operation of a calibration key.

A method for monitoring the pressure of motor vehicle tires during which a tire pressure value which describes the tire filling pressure is determined and the determined tire pressure value is compared with a stored nominal value, and the comparison result is used to deduce whether the motor vehicle tire is at an incorrect tire pressure is known from modern motor vehicles.

Against the background of this prior art, the object of the invention is to specify a method for monitoring the pressure of motor vehicle tires, which on the one hand is more reliable and on the other hand can be carried out more easily and more conveniently for the driver.

This object is achieved by a method having the features of patent claim 1. In this case, a tire pressure value which describes the tire filling pressure is determined in order to monitor the pressure of motor vehicle tires. The determined tire pressure value is compared with a stored nominal value. The comparison result is used to deduce whether the motor vehicle tire is at an incorrect tire pressure, in particular a low tire pressure. In the case of a characteristic change in the tire pressure, the stored nominal value is replaced by

a new nominal value, with the determined tire pressure value being used to determine the new nominal value. Various predeterminable criteria can be checked in order to determine whether a characteristic change has occurred in the tire pressure. The advantage of the method according to the invention is that the method for tire pressure monitoring can on the one hand be carried out fully automatically, while on the other hand the method for tire pressure monitoring takes into account any change which may have occurred deliberately in the tire air pressure, for example as a result of a tire being filled or as a result of a tire change. In particular, in a situation such as this, there is no need for initialization, the inputting of values or calibration by the driver. This means that the method according to the invention is not only more reliable but is also more convenient.

In order to take account of the relationship between the tire pressure and the tire temperature or the temperature of the tire filling means, a tire temperature value can additionally be determined and can be used for correction or normalization of the tire pressure. In the same way, the nominal value can be normalized with respect to a temperature value, or can be stored as a temperature-dependent value. Overall, the method according to the invention can be carried out in such a way that the tire temperature value or the tire temperature values are taken into account for all pressure values. In particular, all pressure values are temperature-compensated.

In one refinement of the method according to the invention, the determined tire pressure value is compared with a stored comparison pressure value, which was determined at an earlier time, with the tire temperature value being taken into account, to

determine whether a characteristic change has occurred in the tire filling pressure. A characteristic change in the tire filling pressure occurs in particular when the difference between the determined tire pressure value and the stored comparison pressure value is greater than a predeterminable threshold value.

In another refinement of the method, a characteristic change in the tire filling pressure occurs when the difference between the determined tire pressure value and the stored comparison pressure value is greater than a predeterminable threshold value for at least two wheels. This threshold value is preferably chosen to be relatively small, for example between 0.1 bar and 0.4 bar. The pressure differences are preferably temperature-compensated.

In a further refinement of the method, a characteristic change in the tire filling pressure occurs only when the vehicle has been stopped or restarted between the time of the determined tire pressure value and the earlier time of storage of the stored comparison pressure value.

In one development of the method, the determined tire pressure value is additionally subjected to a plausibility check, with a new nominal value being stored only when the determinined tire pressure value is classified as being plausible.

In one refinement of this, a tire pressure value such as this is classified as being plausible only if the difference between this first tire pressure value and a further tire pressure value associated with the same vehicle axle and the opposite vehicle side is less than a predeterminable threshold value, for example less than 0.4 bar.

Alternatively or additionally, it is possible for plausibility to check whether all of the determined tire pressure values are above a predeterminable threshold value. By way of example, a tire pressure value is classified as being plausible only when all of the determined tire pressure values are greater than 1.6 bar.

In a further refinement, a tire pressure value is classified as being plausible only when the determined tire pressure value associated with the rear vehicle axle is greater than the mean value of the determined tire pressure values associated with the front vehicle axle, minus a predeterminable constant, in which case, in particular, the constant may be equal to zero.

As a further criterion for plausibility of a determined tire pressure value, it is possible to check whether the difference between the determined tire temperature and an ambient temperature is less than a predeterminable threshold value. By way of example, a tire pressure value is classified as plausible only when the difference between the determined tire temperature and a determined ambient temperature is less than 40°C.

The plausibility conditions described in the above paragraphs can additionally be linked to a time criterion. For example, a tire pressure value is classified as being plausible only when the respective plausibility conditions are satisfied at least for a time period associated with them, in particular for at least five minutes. A characteristic change in the tire filling pressure occurs in particular when the tire filling pressure of one or more tires on the vehicle has been reset by the driver or by someone else, and/or

the tires have been filled with air, or one or more wheels on the vehicle have been replaced. Other criteria which indicate such a deliberate change in the tire air pressure of a vehicle tire may be checked in addition to or as an alternative to the criteria mentioned above, and may be used as a decision criterion or plausibility criterion.

The method according to the invention is preferably carried out in order to monitor the pressure of all of the vehicle tires. If the method is carried out for a plurality of vehicle tires, a separate nominal value may be associated with each tire individually, or with each tire pair arranged on one axle.

One advantageous refinement of the invention is illustrated in the drawing, in which:
Figure 1 shows a method for monitoring the pressure of motor vehicle tires.
Figure 2 shows a refinement of the method part in which a check is carried out to determine whether a characteristic change has occurred in the tire pressure.

Figure 1 shows a method for monitoring the pressure of motor vehicle tires. A tire pressure value which describes the tire filling pressure is determined in step 1. A tire temperature value which describes the tire temperature is determined in step 2. A process is carried out in step 3, using the values determined in step 1 and step 2, to determine whether the tire pressure is incorrect. For this purpose, the determined tire pressure value is compared with a stored nominal value, with the tire temperature value being taken into account. If there is a considerable discrepancy between the tire pressure value and the nominal value, then a jump is made to step 4 in order to initiate an

auxiliary measure, for example the emission of a warning message to the driver. If the tire pressure is found not to be incorrect in step 3, then a jump is made to step 5, in which this method branch can be ended in order subsequently, for example, to restart the method.

In parallel with the method branch described above, a process is carried out in step 6 to determine whether the previous nominal value will be retained, or a new nominal value will be stored. At least the tire pressure value determined in step 1 is used for this purpose. However, further variables may additionally be used to determine a nominal value in step 6. In particular, the tire temperature determined in step 2 is used in step 6.

If it is found in step 6 that the previous nominal value should be retained unchanged, then a jump is made to step 7, in which this method branch can be ended. If the check in step 6 shows that the nominal value should be changed, then a jump is made to step 8, in which a new nominal value is determined and stored. The tire pressure value determined in step 1 is used for this purpose. In addition, further variables, such as the tire temperature determined in step 2, may be used.

The nominal value determined and stored in step 8 is used in step 3 in order to determine whether the tire pressure is incorrect.

As an alternative to carrying out steps 3 and 6 in parallel, they may also be carried out in series one after the other, that is to say with step 3 being carried out before step 6, or step 3 being carried out after step 6. The steps 3 and 6 may also be carried out

with a completely different time arrangement between them.

Figure 2 shows a refinement of the method steps 6 to 8 that are known from figure 1, that is to say a refinement of the method part in which a check is carried out to determine whether a characteristic change has occurred in the tire pressure. The method step 6 is in this case described in more detail by the steps 11 to 15. In this refinement shown in figure 2, the nominal value for the tire pressure is intended to be changed precisely when correction has been identified, in particular a vehicle tire being filled with air. Instead of filling, a deliberate change to the tire filling pressure can also be identified as a correction, for example a pressure reduction or a tire change, as the reason for a change in the nominal value.

In step 11, one or more conditions is or are checked to determine whether the method is carried out further. Examples of conditions such as these are that the ignition has been restarted following the vehicle having been stationary for a predetermined time, for example for at least 3 minutes, a wheel sensor has detected a pressure change when the vehicle was stationary, or a wheel that has newly been fitted to the vehicle is detected after driving starts. Further conditions may be that the tire temperature is within a predeterminable temperature range, a detected tire pressure changes by at most a predeterminable value within a predeterminable observation time period, or a detected tire pressure is above a predeterminable minimum pressure. If one of the predetermined conditions is not satisfied, then a jump is made to step 7a, and the method is terminated.

If all of the predetermined conditions checked in step 11 are satisfied, then a jump is made to step 12, in which the tire pressure values determined in step 1 are used as a function of possible further conditions, such as a predeterminable minimum speed. In this case, the tire pressure values that are used may be used, evaluated, filtered or processed further in some other way, directly.

In the next step 13, a time criterion can be predetermined, so that the method is continued only if all of the conditions required for this purpose are satisfied for a predeterminable minimum time period, for example 3 minutes. If the time criterion is satisfied, then step 13 is followed by a plausibility check being carried out in step 14.

The plausibility check in step 14 can be designed such that a check is carried out for each tire to determine whether this tire has a minimum pressure that is specific for that type. Alternatively or additionally, it is also possible to check whether a tire has a predeterminable axle-specific minimum pressure. A further alternative or supplementary plausibility condition is that the pressure difference between two tires is not greater than a predeterminable minimum pressure, which by way of example can be preset to between 1.0 and 1.5 bar. A maximum permissible pressure difference between two tires on the same axle can be predetermined as a further plausibility condition. A maximum permissible pressure difference such as this is preset, for example, to be 0.5 to 1 bar. Furthermore, it is possible to predetermine as a pressure criterion that the tire pressure of a tire on the rear axle is, for example, at most 0.5 bar less than the mean value of the tire pressure of the tires on the front axle.

If a plausibility criterion is not satisfied, that is to say the plausibility check in step 14 shows that a tire pressure is implausible, a jump is made to 7b. In step 7b, the method for tire pressure monitoring is terminated and a warning message can be emitted, so that the driver is informed of the implausible tire pressure state. For example, the driver is requested to check the tire pressures. The method can also be carried out once again from step 7b before emitting a message to the driver.

If the plausibility check in step 14 shows that the tire pressure values are plausible, then a jump is made to step 15. A check is carried out in step 15 to determine whether a tire pressure has been corrected by means of filling. For this purpose, a tire pressure value which has been determined and stored for one wheel at an earlier time is compared with the currently determined tire pressure value for that wheel. If a comparison such as this for at least two wheels shows a pressure increase or pressure decrease by a predeterminable value, for example 0.2 bar, then it is deduced that the tire pressure has been corrected. In this context, the expression correction also means a deliberate reduction in the tire pressure by the driver. Temperature-compensated tire pressure values are preferably used for identification of the correction of the tire pressure in step 15, as throughout the entire method.

It is also possible to deduce that the tire pressure has been corrected if the tire pressure on one wheel for which a tire pressure warning has been emitted has been changed by at least a predeterminable value, for example has been increased by at least 0.2 bar. In this case, the comparison value is the tire pressure value determined and stored at the time of the warning.

If no correction of a tire pressure is found in step 15, then a jump is made to step 7c, and the method is terminated or is started again. In addition, the determined tire pressure values can be retained, or stored as reference values. Once again, additional conditions may be checked for this purpose.

If a correction to a tire pressure is identified in step 15, a jump is made to step 8. A new nominal value associated with a wheel is stored in step 8. This stored nominal value is used as the new comparison value for the tire pressure check. A plurality of new nominal values for a plurality of wheels may, of course, also be stored. In addition, an information message can be emitted for the driver, informing the driver that changed tire pressures will be monitored in the future. In this case, the pressures may be explicitly indicated to the driver.

The method part described in figure 2 or a method subsection in figure 2 is preferably carried out on a time-controlled basis and, for example, is carried out once or more per second. In particular, the described method procedure in step 11 is started regularly, for example once per second.